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(54) **MULTI-EFFECTS DESALINATION SYSTEM**


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(51) **Int. Cl.**

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| ***C02F 1/04*** | (2006.01) |
| ***B01D 1/28*** | (2006.01) |
| *C02F 103/08* | (2006.01) |

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CPC ... ***C02F 1/04*** (2013.01); ***B01D 1/26*** (2013.01); ***B01D 1/28*** (2013.01); *C02F 2103/08* (2013.01)

(58) **Field of Classification Search**
CPC ......... C02F 1/04; C02F 2103/08; B01D 1/26; B01D 1/28
See application file for complete search history.



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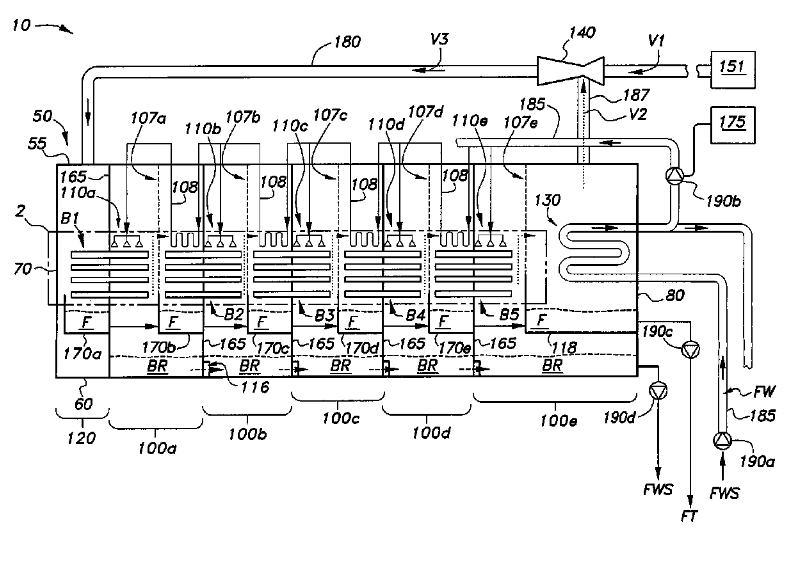
(57) **ABSTRACT**

A multi-effects desalination system includes a housing having a heating box, a plurality of vessels, a plurality of heat rods within each of the vessels, and a condenser unit. Each vessel is separated by a separator wall. Each heat rod extends through one of the separator walls, such that each heat rod has a first end extending into one vessel and a second end extending into an adjacent vessel. The desalination system also includes a plurality of sprayers, a plurality of demisters, and a plurality of trays. Each sprayer is configured to discharge feed water FW onto the second end of each heat rod in a respective vessel and each tray being configured to collect condensate or fresh water. The condensate collected in one to tray can be transferred to the condensate collection tray in an adjacent vessel. Further, the desalination system can also include a thermocompressor unit.


**7 Claims, 11 Drawing Sheets**



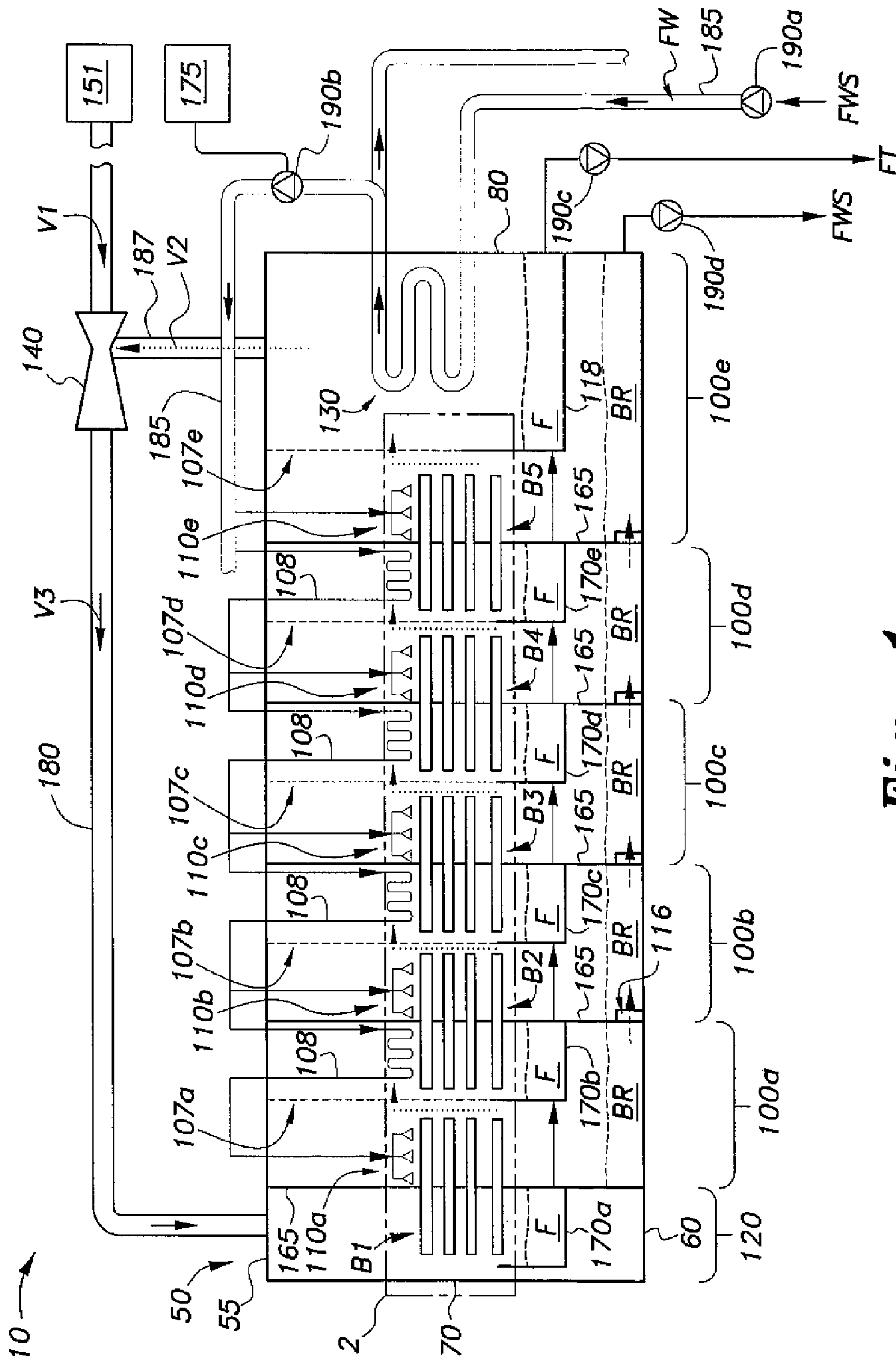

151
175
190b
190a
185
FW
FWS
FT
190c
190d
FWS
80
V1
187
V2
140
185
130
118
F
BR
100e
107e
110e
B5
165
170e
108
100d
107d
110d
B4
170d
100c
107c
110c
B3
170c
100b
107b
110b
B2
116
170b
100a
107a
110a
B1
170a
V3
180
165
60
120
10
50
55
2
70

Fig. 1

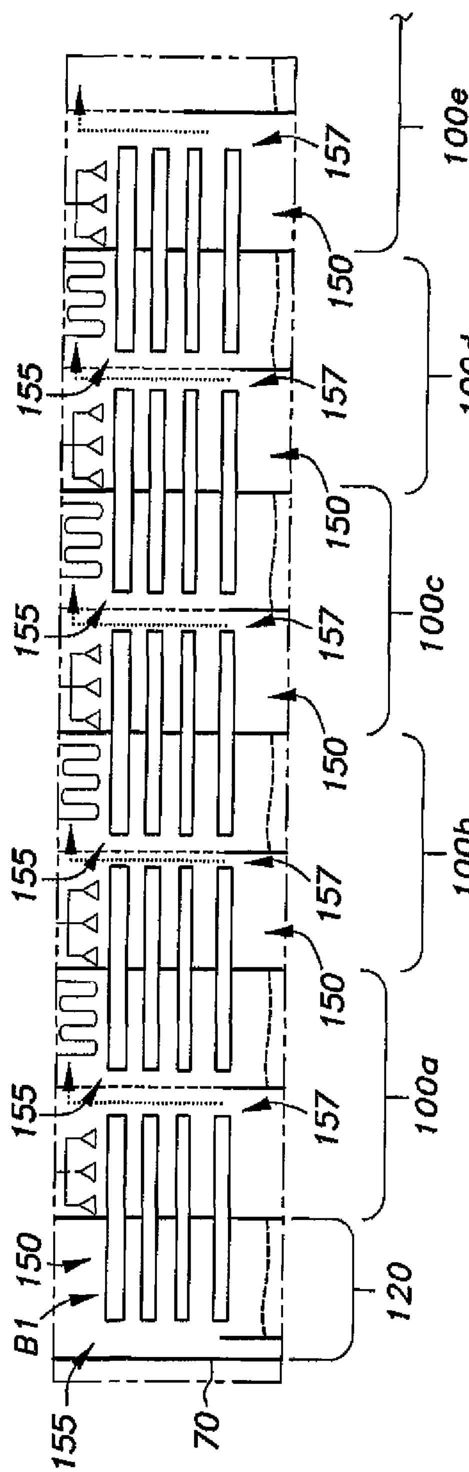

100e
157
150
155
157
100d
150
155
157
100c
150
155
157
100b
150
155
157
100a
150
B1
120
155
70

*Fig. 2*

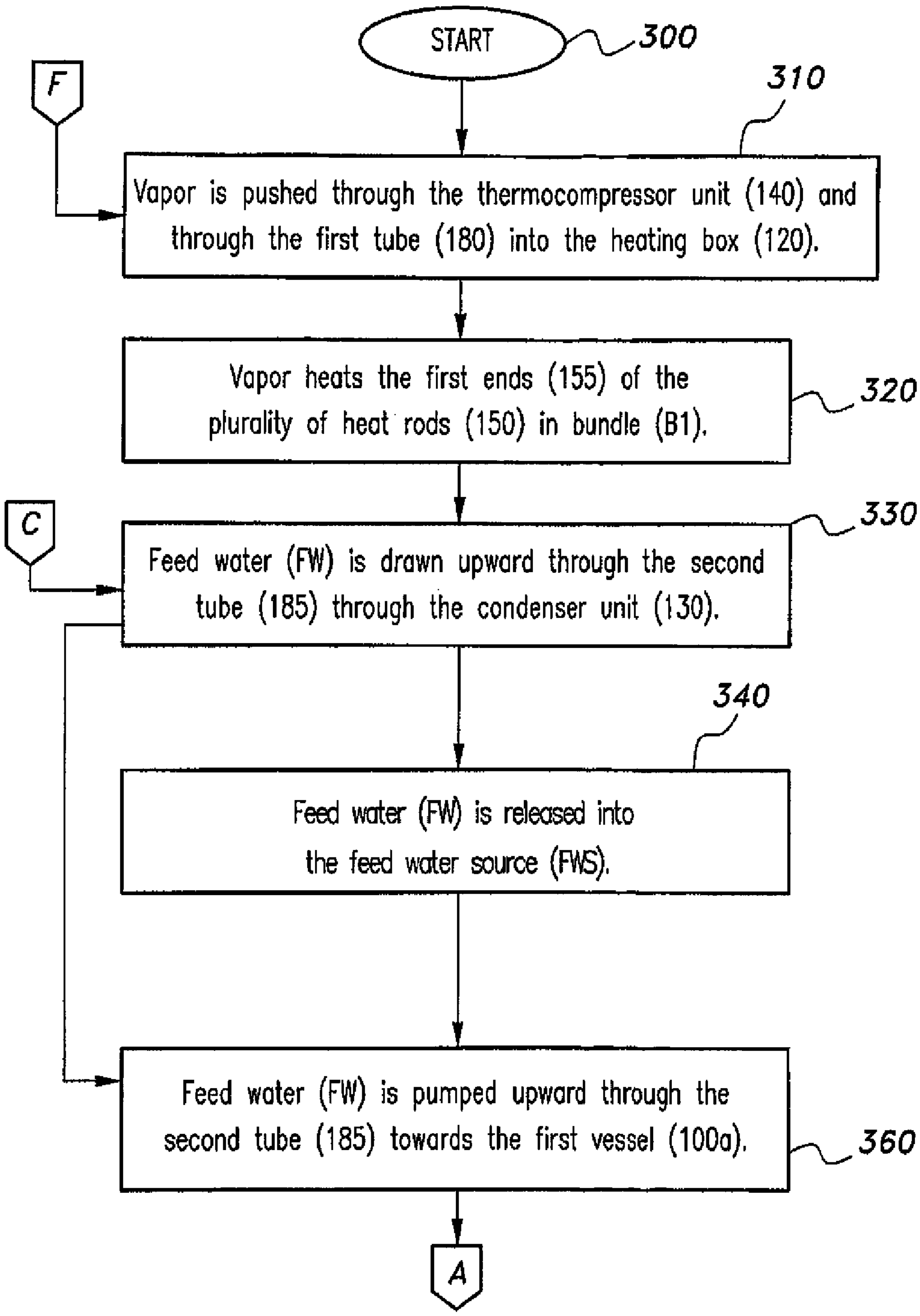

START
300
310
F
Vapor is pushed through the thermocompressor unit (140) and through the first tube (180) into the heating box (120).
Vapor heats the first ends (155) of the plurality of heat rods (150) in bundle (B1).
320
C
330
Feed water (FW) is drawn upward through the second tube (185) through the condenser unit (130).
340
Feed water (FW) is released into the feed water source (FWS).
Feed water (FW) is pumped upward through the second tube (185) towards the first vessel (100a).
360
A

*Fig. 3A*

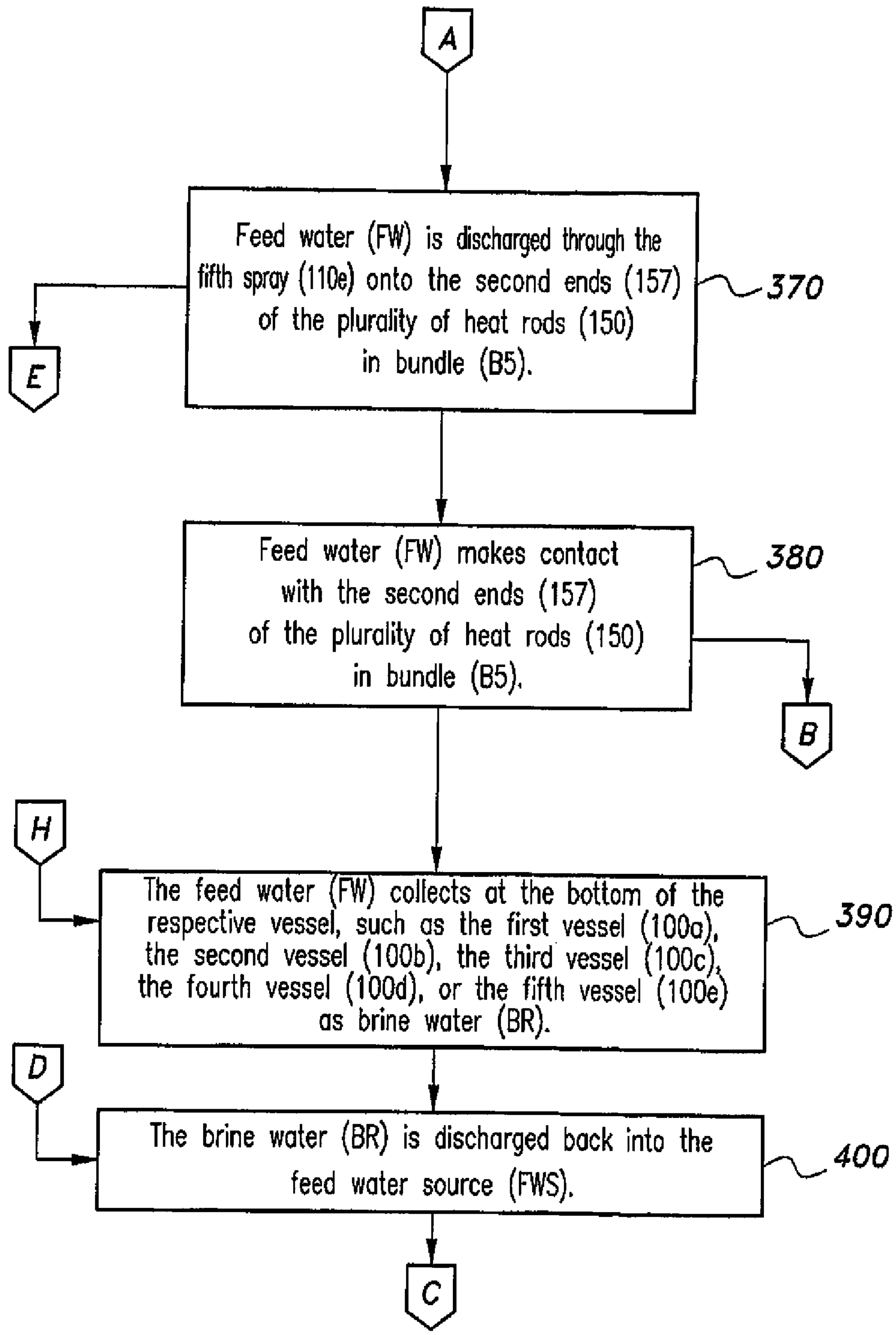

A
Feed water (FW) is discharged through the fifth spray (110e) onto the second ends (157) of the plurality of heat rods (150) in bundle (B5).
370
E
Feed water (FW) makes contact with the second ends (157) of the plurality of heat rods (150) in bundle (B5).
380
B
H
The feed water (FW) collects at the bottom of the respective vessel, such as the first vessel (100a), the second vessel (100b), the third vessel (100c), the fourth vessel (100d), or the fifth vessel (100e) as brine water (BR).
390
D
The brine water (BR) is discharged back into the feed water source (FWS).
400
C

*Fig. 3B*

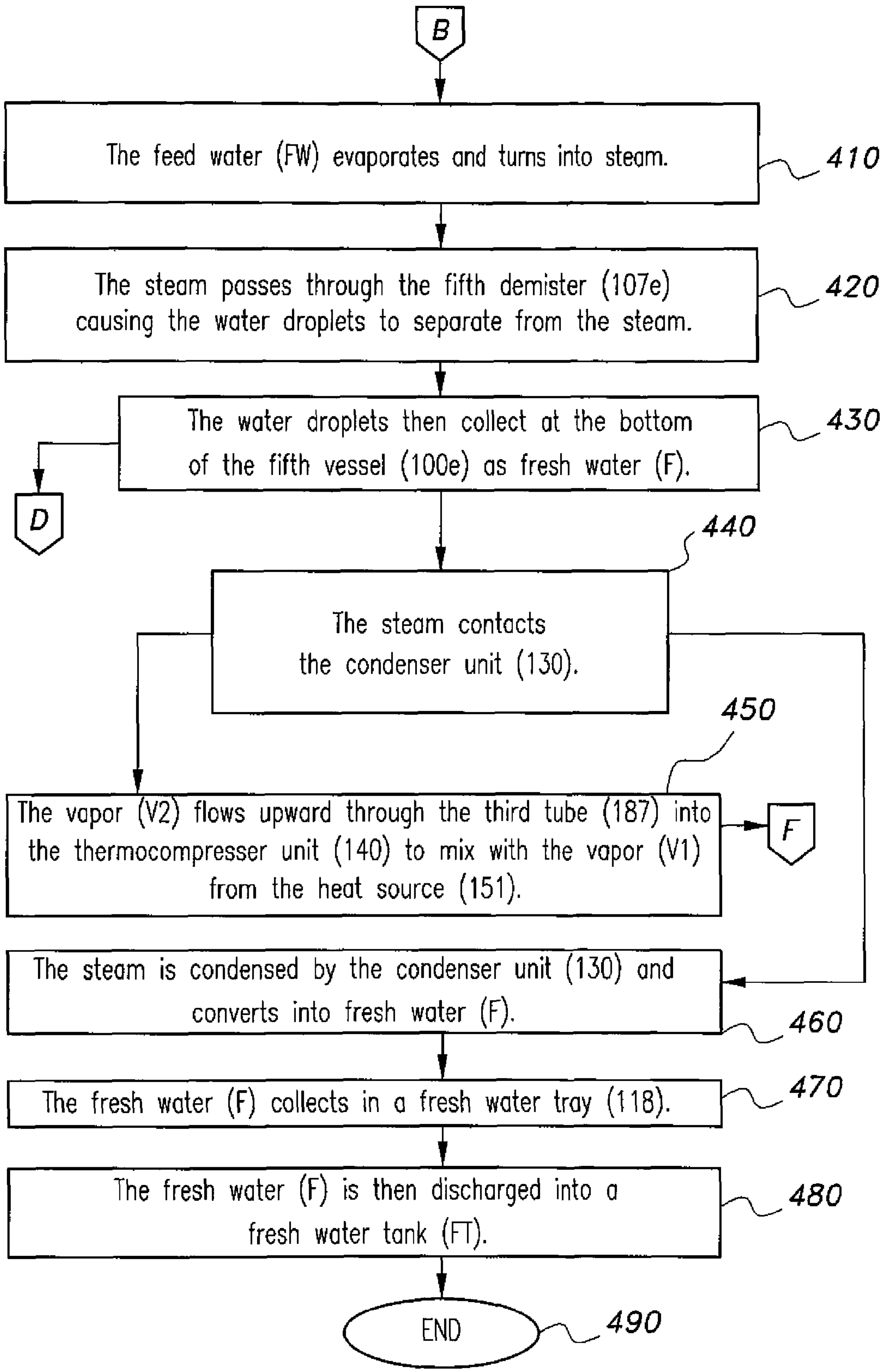

B
The feed water (FW) evaporates and turns into steam.
410
The steam passes through the fifth demister (107e) causing the water droplets to separate from the steam.
420
The water droplets then collect at the bottom of the fifth vessel (100e) as fresh water (F).
430
D
440
The steam contacts the condenser unit (130).
450
The vapor (V2) flows upward through the third tube (187) into the thermocompresser unit (140) to mix with the vapor (V1) from the heat source (151).
F
The steam is condensed by the condenser unit (130) and converts into fresh water (F).
460
The fresh water (F) collects in a fresh water tray (118).
470
The fresh water (F) is then discharged into a fresh water tank (FT).
480
END
490

*Fig. 3C*

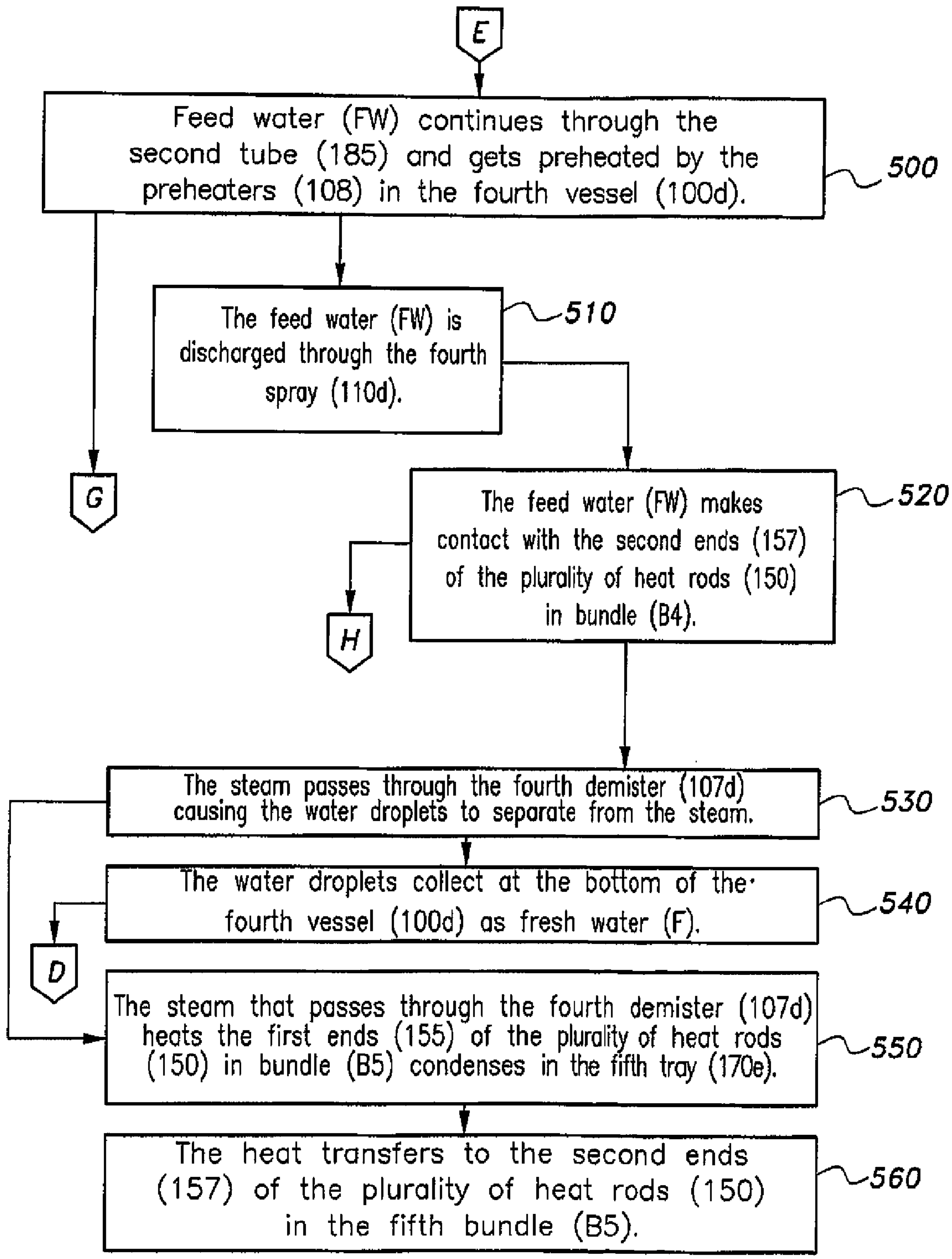

E
Feed water (FW) continues through the second tube (185) and gets preheated by the preheaters (108) in the fourth vessel (100d).
500
The feed water (FW) is discharged through the fourth spray (110d).
510
G
The feed water (FW) makes contact with the second ends (157) of the plurality of heat rods (150) in bundle (B4).
520
H
The steam passes through the fourth demister (107d) causing the water droplets to separate from the steam.
530
The water droplets collect at the bottom of the fourth vessel (100d) as fresh water (F).
540
D
The steam that passes through the fourth demister (107d) heats the first ends (155) of the plurality of heat rods (150) in bundle (B5) condenses in the fifth tray (170e).
550
The heat transfers to the second ends (157) of the plurality of heat rods (150) in the fifth bundle (B5).
560

*Fig. 3D*

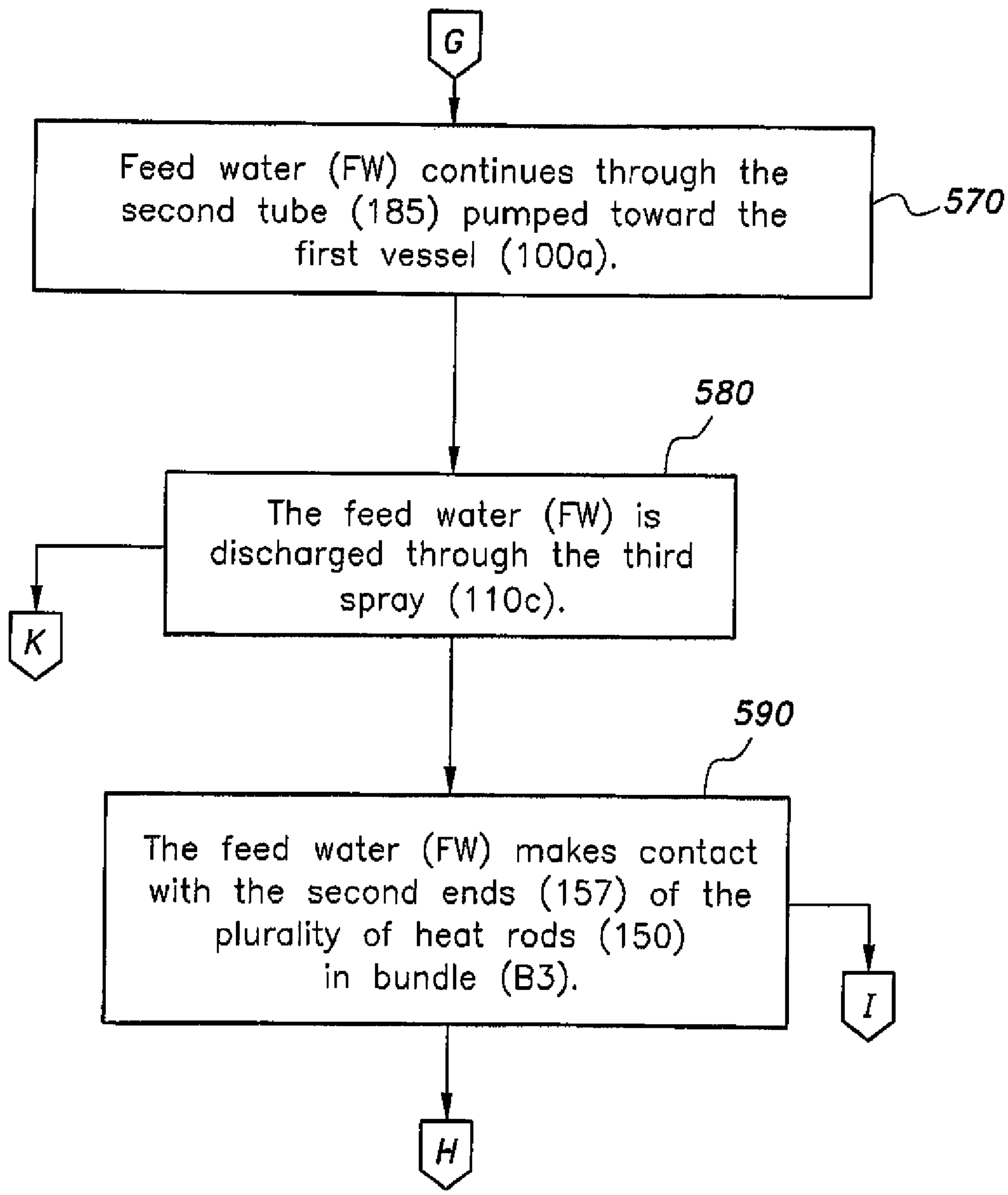

G
Feed water (FW) continues through the second tube (185) pumped toward the first vessel (100a).
570
580
The feed water (FW) is discharged through the third spray (110c).
K
590
The feed water (FW) makes contact with the second ends (157) of the plurality of heat rods (150) in bundle (B3).
I
H

*Fig. 3E*

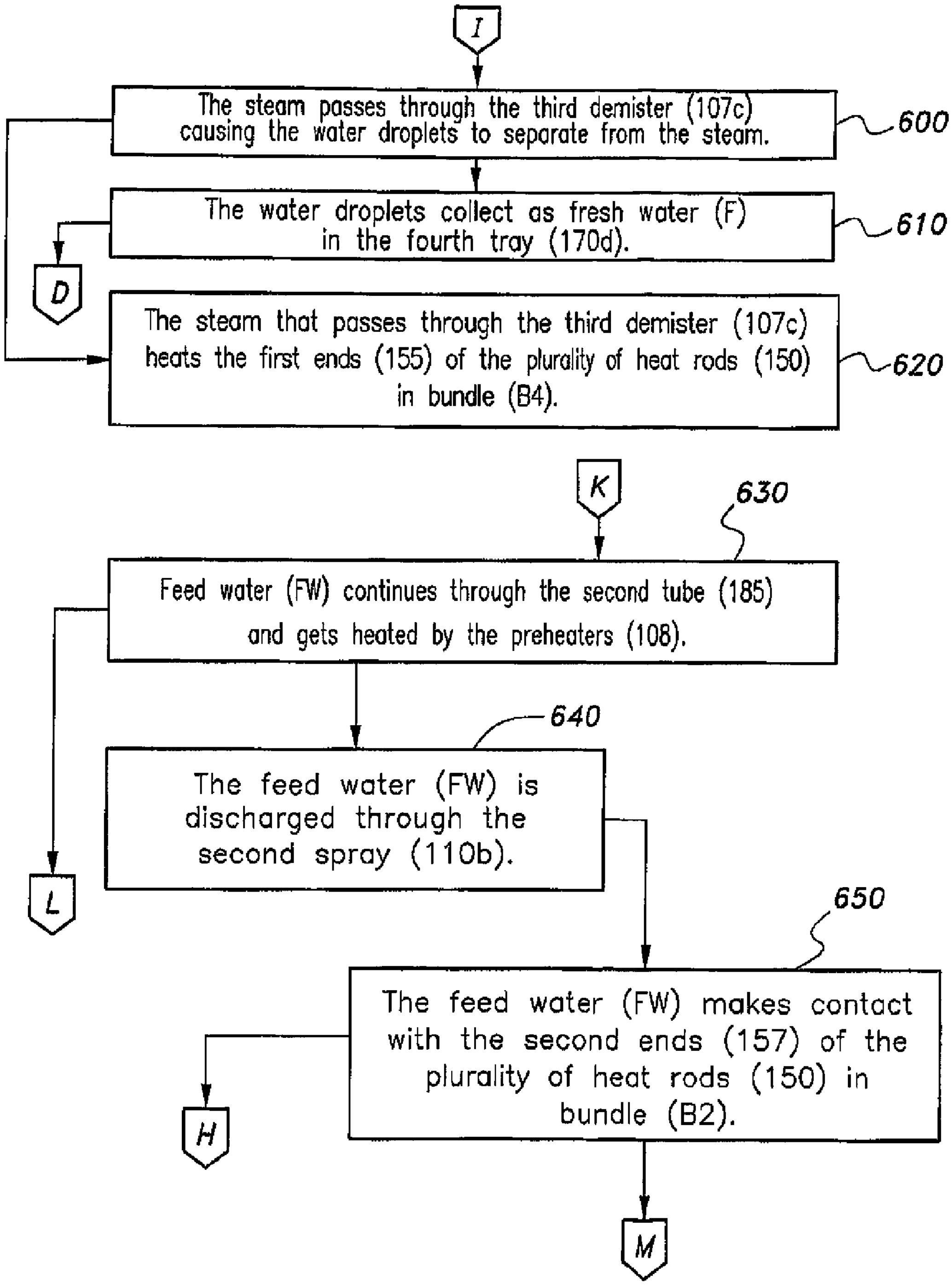

I
The steam passes through the third demister (107c) causing the water droplets to separate from the steam.
600
The water droplets collect as fresh water (F) in the fourth tray (170d).
610
D
The steam that passes through the third demister (107c) heats the first ends (155) of the plurality of heat rods (150) in bundle (B4).
620
K
630
Feed water (FW) continues through the second tube (185) and gets heated by the preheaters (108).
640
The feed water (FW) is discharged through the second spray (110b).
L
650
The feed water (FW) makes contact with the second ends (157) of the plurality of heat rods (150) in bundle (B2).
H
M

*Fig. 3F*

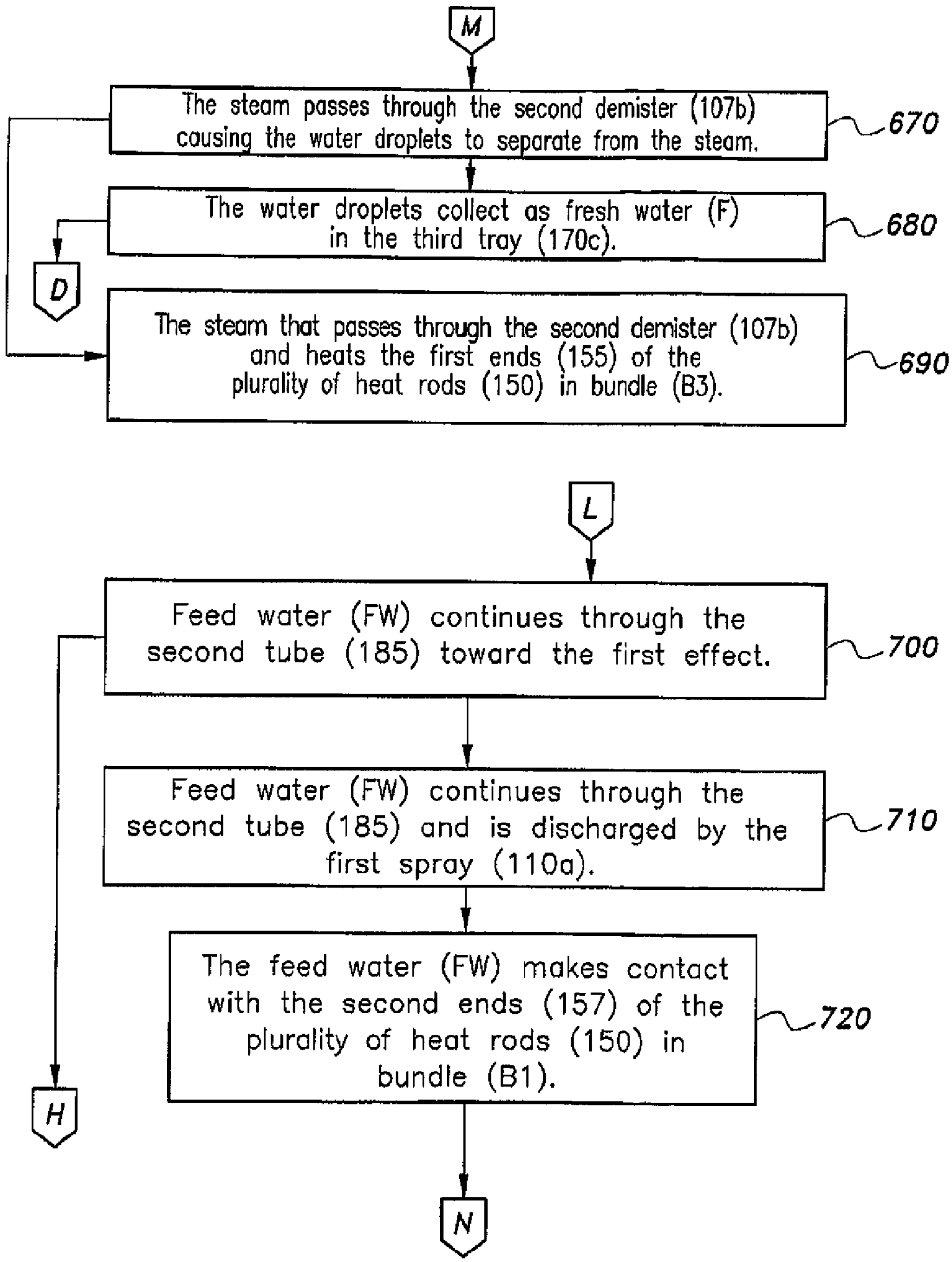

M
The steam passes through the second demister (107b) causing the water droplets to separate from the steam.
670
The water droplets collect as fresh water (F) in the third tray (170c).
680
D
The steam that passes through the second demister (107b) and heats the first ends (155) of the plurality of heat rods (150) in bundle (B3).
690
L
Feed water (FW) continues through the second tube (185) toward the first effect.
700
Feed water (FW) continues through the second tube (185) and is discharged by the first spray (110a).
710
The feed water (FW) makes contact with the second ends (157) of the plurality of heat rods (150) in bundle (B1).
720
H
N

*Fig. 3G*

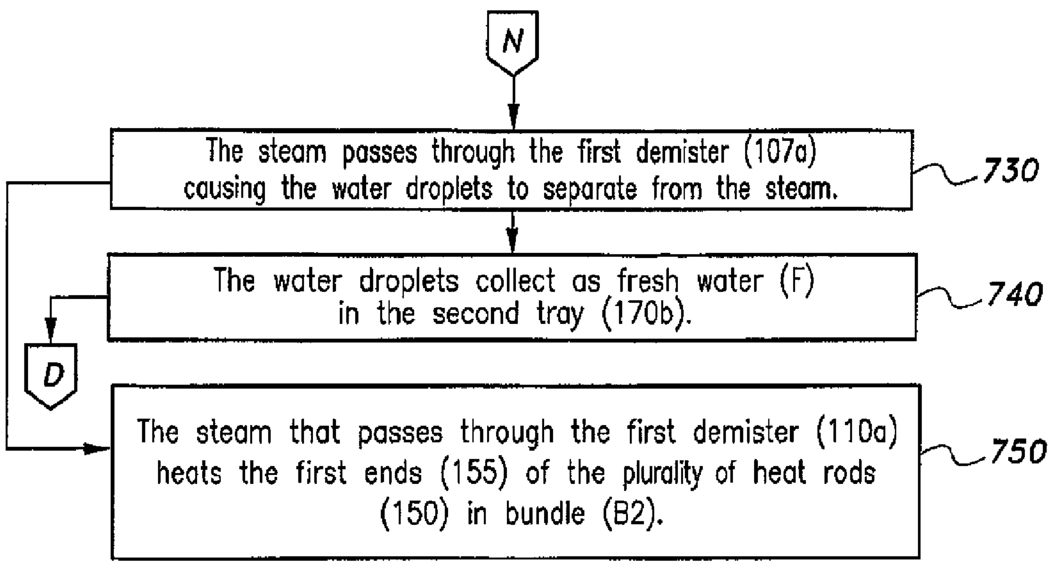

N
The steam passes through the first demister (107a) causing the water droplets to separate from the steam.
730
The water droplets collect as fresh water (F) in the second tray (170b).
740
D
The steam that passes through the first demister (110a) heats the first ends (155) of the plurality of heat rods (150) in bundle (B2).
750

*Fig. 3H*

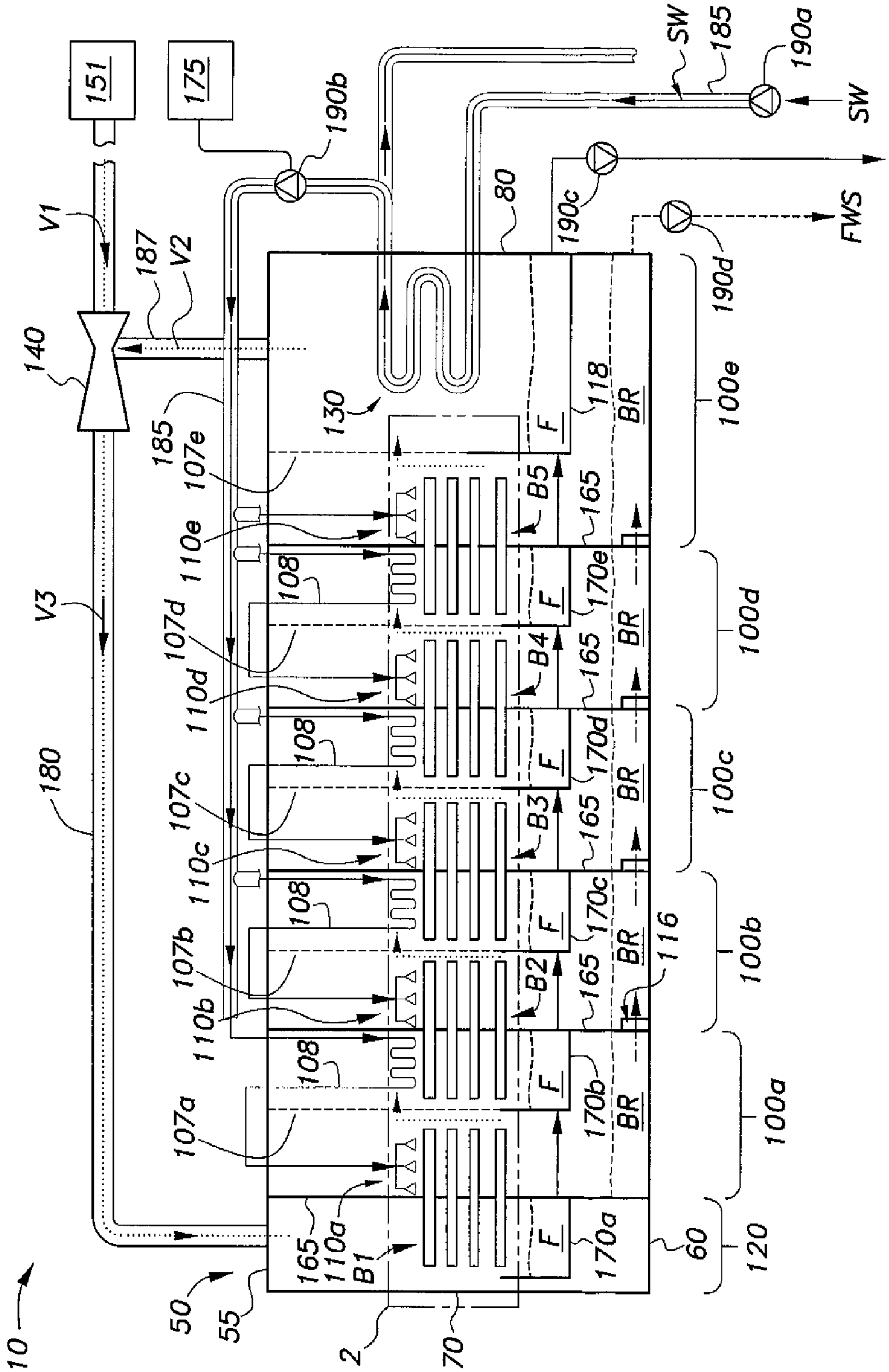

10
50
55
2
70
60
120
165
110a
B1
F
170a
100a
107a
108
170b
BR
110b
107b
B2
165
116
100b
110c
107c
B3
170c
100c
110d
107d
B4
170d
100d
110e
107e
B5
170e
100e
118
130
80
185
187
140
V1
V2
V3
180
151
175
190b
190a
190c
190d
SW
FT
FWS

*Fig. 4*

# MULTI-EFFECTS DESALINATION SYSTEM

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to desalination systems and, more particularly, to a modified multi-effect distillation thermal vapor compression (MED-TVC) desalination system having a plurality of heat rods.

2. Description of the Related Art

Multiple-effect distillation with thermal vapor compression (MED-TVC) is a process used for sea water desalination. Typically, the MED-TVC systems produce desalinated (distillate) water from seawater (salt water), through a multi-stage system which includes horizontal tube bundles at each stage. In each stage, feed water is heated and partially evaporated by the vapor condensing inside the tubes. Saline water evaporates in one stage, and the vapor flows into the tubes of a subsequent stage. Each stage reuses energy from a previous stage. However, the vapor velocity inside the evaporator tubes drops dramatically as it condenses along evaporator tubes. Also, the two phase pressure loss caused by vapor condensing inside the evaporator tubes is high, leading to considerable temperature loss and increase in evaporator heating surface area.

Thus, a multi-effects desalination system solving the aforementioned problems is desired.

## SUMMARY OF THE INVENTION

A multi-effects desalination system includes a housing having a heating box, a plurality of vessels, a plurality of heat rods within each of the vessels, and a condenser unit. Each vessel is separated by a separator wall. Each heat rod extends through one of the separator walls, such that each heat rod has a first end extending into one vessel and a second end extending into an adjacent vessel. The desalination system also includes a plurality of sprayers and a plurality of demisters. Each sprayer is configured to discharge feed water into a respective one of the vessels, e.g., onto the second end of each heat rod in a respective vessel. Each of a plurality of trays, including a first tray, a second tray, a third tray, a fourth tray, and a fifth tray, are positioned underneath the first ends of the heat rods for collecting condensate or fresh water. The condensate collected in one tray can be transferred to the condensate collection tray in an adjacent vessel. Further, the desalination system can also include a thermocompressor unit arranged in communicating relation with a steam source.

These and other features of the present invention will become readily apparent upon further review of the following specification and drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of an embodiment of a desalination system having a plurality of effects according to the present invention.

FIG. **2** is a schematic diagram of a portion of the desalination system shown in FIG. **1**, showing the ends of the plurality heat rods for the desalination system according to the present invention.

FIG. **3**A a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**B a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**C a flowchart illustrating a method to desalinate seawater according to the present invention.



FIG. **3**D a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**E a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**F a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**G a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **3**H a flowchart illustrating a method to desalinate seawater according to the present invention.

FIG. **4** is a schematic diagram of another embodiment of a desalination system having a plurality of effects according to the present invention.

Similar reference characters denote corresponding features consistently throughout the attached drawings.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIGS. **1** and **2**, a multi-effects desalination system **10** includes a housing **50** having a heating box **120**, a plurality of vessels, including a first vessel **100***a*, a second vessel **100***b*, a third vessel **100***c*, a fourth vessel **100***d*, and a fifth vessel **100***e*, a plurality of heat rods **150** within each of the vessels, and a condenser unit **130**. Each vessel **100***a*-**100***e* is separated by a separator wall **165**. By separating each vessel **100***a*-**100***e* with a separator wall **165**, the desalination system **10** can reduce temperature loss and reduce the amount of pressure needed to desalinate feed water FW. Each heat rod **150** extends through one of the separator walls **165**. Each heat rod **150** has a first end **155** extending into one vessel and a second end **157** extending into an adjacent vessel (FIG. **2**). The desalination system **10** also includes a plurality of sprayers, including a first sprayer **110***a*, a second sprayer **110***b*, a third sprayer **110***c*, a fourth sprayer **110***d*, and a fifth sprayer **110***e*. Each sprayer is configured to discharge feed water FW in a respective one of the vessels. For example, each sprayer can discharge feed water FW, such as seawater, onto the second end **157** of each heat rod **150** in a respective vessel. Each of a plurality of trays, including a first tray **170***a*, a second tray **170***b*, a third tray **170***c*, a fourth tray **170***d*, and a fifth tray **170***e*, are positioned underneath the first ends **155** of the heat rods **150** for collecting condensate or fresh water (F). The condensate collected in one tray can be transferred to the condensate collection tray in an adjacent vessel through tubing extending between and connecting trays **170***a*-**170***e*. Further, the desalination system **10** can optionally include a thermocompressor unit **140** arranged in communicating relation with a steam source **151**.

The first vessel **100***a*, the second vessel **100***b*, the third vessel **100***c*, the fourth vessel **100***d*, and the fifth vessel **100***e* are each configured to accommodate a different effect or stage of desalination occurring in the system **10**. The plurality of heat rods **150** can be arranged in any suitable configuration in the vessels. For example, a first bundle of heat rods B**1**, can include a first plurality of heat rods **150**, with first ends **155** disposed in the heat box **120** and second ends **157** disposed in the first vessel **100***a*. A second bundle of heat rods B**2**, can include a second plurality of heat rods **150**, with first ends **155** disposed in the first vessel **100***a* and second ends **157** disposed in the second vessel **100***b*. A third bundle of heat rods B**3**, can include a third plurality of heat rods **150**, with first ends **155** disposed in the second vessel **100***b* and second ends **157** disposed in the third vessel **100***c*. A fourth bundle of heat rods B**4**, can include a fourth plurality of heat rods **150**, with first ends **155** disposed in the third vessel **100***c* and second ends disposed in the fourth vessel **100***d*. A fifth bundle of heat rods B**5**, can include a fifth plurality of heat rods **150**, with first ends **155** disposed in the fourth vessel **100***d* and second ends in the fifth vessel **100***e*.

The desalination system **10** further includes a plurality of demisters including a first demister **107***a*, second demister **107***b*, a third demister **107***c*, a fourth demister **107***d*, and a fifth demister **107***e*. The first demister **107***a* extends between the first bundle of heat rods B**1** and the second bundle of heat rods B**2**. The second demister **107***b* extends between the second bundle of heat rods B**2** and the third bundle of heat rods B**3**. The third demister **107***c* extends between the third bundle of heat rods B**3** and the fourth bundle of heat rods B**4**. The fourth demister **107***d* extends between the fourth bundle of heat rods B**4** and the fifth bundle of heat rods B**5**. A plurality of pumps **190***a*-**190***d* are provided, including a first pump **190***a* configured for pumping feed water FW upward through a second tube **185** from a feed water source FWS, such as the ocean, a second pump **190***b* configured to pump the feed water FW through the second tube **185** toward the first vessel **100***a*, a third pump **190***c* configured to pump fresh water F from a fresh water tray **118** into a fresh water tank FT, and a fourth pump **190***d* configured for pumping brine water BR into the feed water source FWS.

The desalination system **10** can also include a power source **175**, such as solar panels or wind turbines, coupled to the first pump **190***a*, the second pump **190***b*, the third pump **190***c*, and/or the fourth pump **190***d* to power the desalination system **10**. The thermocompressor unit **140** receives a first vapor V**1** from the steam source **151**. The steam source can be a conventional boiler or any type of suitable steam boiler operating from a renewable energy source such as solar, geothermal, waste heat, or a biomass energy source. The first vapor V**1** is used to extract a second vapor V**2** from one or more vessels **100***a*-**100***e* through a third tube **187** to create a total or combination vapor V**3**, which is fed into the heating box **120** through a first tube **180**.

The first ends **155** of the plurality of heat rods **150** in bundle B**1** are heated in the heating box **120**. Heat is transferred from the first ends **155** to the second ends **157** of the heat rods **150** in bundle B**1**. The first spray **110***a* releases feed water FW onto the second ends **157** of the plurality of heat rods **150** in the first vessel **100***a* to generate steam. In other words, heat transferred from the first ends **155** to the second ends **157** partially evaporates the spray of water falling from the sprayer **110***a*. The vapor or steam produced in the first vessel **100***a* flows through the demister **107***a*. The demister **107***a* separates water droplets from the steam, which are collected in the second tray **170***b*. The remaining steam heats the first ends **155** of the second bundle B**2** of heat rods **150**. In this manner, the first ends **155** of the heat rods **150** of the second bundle B**2** are heated. The steam flowing through the demister **107***a* also provides heat to the preheater tubes **108** in the first vessel **100***a*. The preheater tubes **108** can heat water that is fed into the first vessel **100***a*. Vapor is produced in the remaining vessels **100***b*-**100***d* and transferred to an adjacent vessel in a similar fashion. The vapor formed in the last vessel **100***e* is forwarded to the condenser unit **130** through the demister **107***e*. The condenser unit **130** condenses the generated steam into fresh water F to be pumped into the fresh water tank FT at atmospheric pressure. As condensation occurs on outer surfaces of the pipes or tubes and not inner surfaces, pressure drop inside the tube and associated temperature loss are avoided.

It is contemplated that there can be "n" effects (stages) and "n" corresponding vessels in the desalination system **10**, whereas "n" can be either greater than or less than five. It is to be noted that each of the plurality of (desirably five) effects (stages) occurs in a separate vessel. For example, the first effect can take place in the first vessel **100***a*, the second effect can take place in the second vessel **100***b*, the third effect can take place in the third vessel **100***e*, the fourth effect can take place in the fourth vessel **100***d*, and the fifth effect can take place in the fifth or last vessel **100***e*. Further, each effect (stage) can operate at a higher boiling temperature and pressure than the subsequent effect (stage).

The housing **50** can have a top portion **55**, a bottom portion **60**, a first side **70**, and a second side **80**. The housing **50** can be made from any suitable material, such as steel, configured to retain heat and collect the brine water BR. The plurality of vessels, such as the first vessel **100***a*, the second vessel **100***b*, the third vessel **100***c*, the fourth vessel **100***d*, and the fifth vessel **100***e* can have any suitable shape, such as a generally rectangular shape, and can be arranged in a horizontal configuration, as illustrated in FIG. **1**. The separator wall **165** separating each vessel can include an opening **116**, to allow the brine BR to flow and flash through the successive vessels, e.g., from the first vessel **100***a* through the second vessel **100***b*, the third vessel **100***c*, the fourth vessel **100***d*, and the fifth vessel **100***e*, so that the brine BR can be discharged into the feed water source FWS. Tubing connecting the first through fifth trays **170***a*-**170***e* and the fresh water tray **118** can also extend through the separator walls **165**.

The heating box **120** can be made from any suitable material, such as steel. The heating box **120** can have any suitable shape, such as a generally rectangular shape. The heating box **120** can house the first ends **155** of the plurality of heat rods **150** in bundle B**1**. Further, the condenser unit **130**, configured to cool the steam received from the fifth vessel **100***e*, can be positioned in the fifth vessel **100***e*. The fifth vessel **100***e* can house the second ends **157** of the plurality of heat rods **150** in bundle B**5**, as illustrated in FIG. **1**.

Each of the plurality of heat rods **150** can be formed from steel, or any suitable material that can absorb large amounts of heat, such as the heat from the vapor V**3** emitted by the thermocompressor **140**, and can have any suitable length and width sufficient to absorb the maximum amount of heat emitted by the thermocompressor unit **140**. It is to be noted that the plurality of heating rods **150** can include a plurality of heating rods, heating pipes, or heat pipe systems. Each of the bundles B**1**, B**2**, B**3**, B**4**, and B**5** can extend through a respective one of the separator walls **165**, so that the heat received by the first ends **155** in one vessel can be transferred to the second ends **157** of the plurality of heat rods **150** in an adjacent vessel.

The first ends **155** of each heat rod **150** in bundle B**1** can be positioned in the heating box **120** so as to receive the heat from the steam introduced by the thermocompressor unit **140** through the first tube **180**. The first ends **155** transfer the heat to the corresponding second end **157** of each heat rod **150** in bundle B**1** positioned in the first vessel **100***a*. When the second ends **157** receive the feed water FW from the first spray **110***a*, steam is created. The steam passes through the demister **107***a* and heats the first ends **155** of each heat rod **150** in bundle B**2** that are housed in the first vessel **100***a*. The second ends **157** of the plurality of heat rods **150** in bundle B**1** are separated from the first ends **155** of the plurality of heat rods **150** in bundle B**2** by the first demister **107***a*.

The first ends **155** of each heat rod **150** in bundle B**2** can be housed in the first vessel **100***a* and the corresponding second ends **157** of each heat rod **150** in bundle B**2** can be housed in the second vessel **100***b*. The first ends **155** of each heat rod **150** in bundle B**3** can be housed in the second vessel **100***b* and the corresponding second ends **157** of each heat rod **150** in bundle B**3** can be housed in the third vessel **100***c*. The second ends **157** of the plurality of heat rods **150** in bundle B**2** can be separated from the first ends **155** of the plurality of heat rods **150** in bundle B**3** by the second demister **107***b*, as illustrated in FIG. **1**. The number of effects will determine the number of bundles of heat rods in the desalination system **10**, as well as the corresponding number of demisters.

Each sprayer **110***a*-**110***e* can be positioned within a respective vessel **100***a*-**100***e* over the second ends **157** of the plurality of heat rods **150** in a respective bundle B**1**, B**2**, B**3**, B**4**, and B**5**. Each of the plurality of sprayers **110***a*-**110***e* can be arranged in communicating relation with the second tube **185**, thereby receiving the feed water FW from the feed water source FWS. The sprayers, such as sprayers **100***a*-**110***c*, can be any suitable type of sprayer, as is well known in the art, configured to discharge the feed water FW received from the feed water source FWS onto the second ends **155** of the plurality of heat rods **150** housed within each of the plurality of vessels.

It is to be noted that the feed water FW can be fed through the second tube **185** and into the plurality of sprayers by any suitable configuration. In one embodiment, for example, the sprayers **110***a*-**110***e* can be arranged in series, as illustrated in FIG. **1**, in which the feed water FW passes through each preheater tube **108** and corresponding sprayer, such as sprayers **110***a*-**110***e*, successively. In another embodiment, the sprayers **110***a*-**110***e* can be arranged in parallel, as illustrated in FIG. **4**, in which the feed water FW passes through each preheater tube **108** and each corresponding sprayer, such as sprayers **110***a*-**110***e*, at the same time.

Referring to FIGS. **3**A-**3**H, a process by which feed water FW, such as seawater, is desalinated using the desalination system **10** is described. To start (Step **300**) the desalination system **10**, vapor V**1** is pushed through the thermocompressor unit **140** and through the first tube **180** into the heating box **120** (Step **310**). The vapor then comes in contact with the first ends **155** of the plurality of heat rods **150** in bundle B**1** and heats the first ends **155** of the plurality of heat rods **150** in bundle B**1** (Step **320**). Any condensation that results from the heating of the first ends **155** of the plurality of heat rods **150** in bundle B**1**, as described in Step **320**, can be collected as fresh water F by the first tray **170***a* and throttled to the second tray **170***b*, Feed water FW is drawn upward by the first pump **190** through the second tube **185** and through the condenser unit **130** (Step **330**). After the feed water FW passes through the condenser unit **130**, some of the feed water FW is pumped through the second tube **185** towards the first vessel **100***a* (Step **360**) and a remaining portion of the feed water FW is released back into the feed water source FWS (Step **340**), where the feed water FW can get drawn upward again through the second tube **185** to the condenser unit **130** (Step **360**).

The feed water FW in the second tube **185** is discharged through the fifth spray **110***e* onto the second end **157** of the plurality of heat rods **150** in bundle B**5** (Step **370**). The feed water FW makes contact with the second ends **157** of the plurality of heat rods **150** in bundle B**5** (Step **380**), and a portion of the feed water FW collects at the bottom of the fifth vessel **100***e* (Step **390**) as brine BR. The brine BR is then discharged into the feed water source FWS (Step **400**).

Once the feed water FW makes contact with the second ends **157** of the plurality of heat rods **150** in bundle B**5** as described in Step **380**, a portion of the feed water FW evaporates and turns into steam (Step **410**). The steam that is produced passes through the fifth demister **107***e* that separates the second ends **157** of the plurality of heat rods **150** in bundle B**5** from the condenser unit **130**, thereby causing water droplets to separate from the steam (Step **420**). The water droplets then collect at the bottom of the fifth vessel **100***e* as fresh water F (Step **430**).

Some of the steam in the fifth vessel **100***c* is drawn up as vapor V**2** through the third tube **187** into the thermocompressor unit **140** to mix with the vapor V**1** from the steam source **151** (Step **450**) and the process continues as described in Step **310**. The remaining steam in the fifth vessel **100***e* contacts the condenser unit **130**, condenses on the tube bundle of the condenser unit **130**, and is thereby converted into fresh water F (Step **460**). The fresh water F collects in the fresh water tray **118** (Step **470**). The fresh water F is then discharged into the fresh water tank FT (Step **480**) and the process ends (Step **490**).

A portion of the feed water FW in tube **185** is discharged through the sprayer **110***e* as described in Step **370**, and a remaining portion of the feed water FW continues through the second tube **185** and is progressively fed into each of the adjacent vessels **100***a*-**100***d* (Step **500**). The feed water FW is preheated by the preheater tubes **108** of the fourth vessel **100***d* and is discharged through the fourth sprayer **110***d*, contacting the second ends **157** of the plurality of heat rods **150** in bundle B**4**. A portion of the feed water evaporates (Step **520**) or transforms to steam which passes through the fourth demister **107***d* causing water droplets to separate from at least some of the steam (Step **530**). After the water droplets separate from the steam, the water droplets collect in the tray **170***e* as fresh water (Step **540**). The steam remaining in the fourth vessel **100***d* heats the first ends **155** of each of the plurality of heat rods **150** in bundle B**5** (Step **550**). The heat transfers to the second ends **157** of the plurality of heat rods **150** in the fifth bundle B**5** (Step **560**).

A portion of the feedwater in the second tube **185** is preheated by the preheater tubes **108** of the fourth vessel **100***d* and a remaining portion continues into the third vessel **100***c*. In the third vessel **100***c*, the feed water FW is preheated by the preheater tubes **108** and discharged through the third spray **110***c* (Step **580**). When the feed water FW is discharged by the third spray **110***c*, it makes contact with the second ends **157** of the plurality of heat rods **150** in bundle B**3** and a portion of the feed water evaporates and transforms into steam (Step **590**). The steam passes through the third demister **107***c* causing water droplets to separate from at least some of the steam (Step **600**). After the water droplets separate from the steam, the water droplets collect in tray **170***d* as fresh water F (Step **610**). The steam remaining in the third vessel **100***c* heats the first ends **155** of the plurality of heat rods **150** in bundle B**4** (Step **620**).

The remaining feed water FW flowing through the second tube **185** continues through the second tube **185** and is preheated by the preheater tubes **108** in the second effect (Step **630**). The feed water FW is discharged through the second spray **110***b* (Step **640**) and makes contact with the second ends **157** of the plurality of heat rods **150** in bundle B**2** (Step **650**). The feed water FW evaporates and converts into steam upon contacting the second ends **157** of the plurality of heat rods **150** in bundle B**2**. The steam passes through the second demister **107***b* causing the water droplets to separate from the steam (Step **670**). After the water droplets separate from the steam, the water droplets collects in the third tray **170***c* as fresh water F (Step **680**). The steam that passes through the second demister **107***b* heats the first ends **155** of the plurality of heat rods **150** in bundle B**3** (Step **690**).

The remaining feed water FW flowing through the second tube **185** is preheated by preheaters **108** in the first vessel **100***a* as it is pumped into the first effect (Step **700**). The feed water FW continues through the second tube **185** and is discharged by the first spray **110***a* (Step **710**). Once the feed water FW is discharged by the first spray **110***a*, the feed water FW makes contact with the second ends **157** of the plurality of heat rods **150** in bundle B**1** (Step **720**). The spray evaporates upon contacting the second ends **157** of the plurality of heat rods **150** in bundle B**1**. The steam passes through the first demister **107***a* causing the water droplets to separate from the steam (Step **730**). After the water droplets separate from the steam, the water droplets collect in tray **170***b* as fresh water F (Step **740**). The steam that passes through the first demister **107***a* heats the first ends **155** of the plurality of heat rods **150** in bundle B**2** (Step **750**).

It is to be understood that the present invention is not limited to the embodiments described above, but encompasses any and all embodiments within the scope of the following claims.

We claim:

**1**. A desalination system, comprising:

a housing including a heating box, a condenser unit, a plurality of vessels, and a plurality of separator walls, each separator wall between adjacent vessels;

a first tubing;

a thermocompressor unit operatively connected to the heating box by the first tubing;

a plurality of demisters, each of the plurality of demisters being substantially vertically disposed in a respective one of the plurality of vessels;

a plurality of heat rods disposed horizontally in each vessel, each heat rod having a first end and a second end, the first end extending into one of the plurality of vessels and the second end extending into an adjacent one of the plurality of vessels;

wherein each of the plurality of heat rods extend through the separator wall between adjacent vessels;

a plurality of sprayers, each of the plurality of sprayers positioned in a respective one of the plurality of vessels;

a plurality of preheaters, each of the plurality of preheaters positioned in a respective one of the plurality of vessels;

at least one condensate tray disposed in each one of the plurality of vessels for receiving condensate;

a second tubing extending between a feed water source, the plurality of preheaters, and the plurality of sprayers; and

a plurality of pumps, each pump designed and configured for selectively moving fluid;

wherein the fluid is selectively moved through the second tubing, and from the at least one condensate tray.

**2**. The desalination system according to claim **1**, further comprising a steam source.

**3**. The desalination system according to claim **1**, further comprising a fresh water tray in communication with each one of the at least one condensate tray in each of the plurality of vessels for receiving fresh water.

**4**. A desalination system, comprising:

a heating box;

a condenser unit;

a plurality of vessels disposed between the heating box and the condenser unit wherein each vessel of the plurality of vessels consisting of:

a preheater;

a sprayer;

at least one condensate tray for receiving condensate;

a demister vertically disposed therein for separating water droplets from water vapor; and

a floor for collecting brine;

a plurality separator walls;

wherein the plurality of separator walls operatively disposed between the heating box, the plurality of vessels, and the condenser unit;



each one the separator walls between adjacent vessels and the condenser unit including an opening configured to allow brine to flow therethrough;

a plurality of heat rod groups, each heat rod group extending horizontally through one of a corresponding separator wall;

wherein a first end of each heat rod in each of the heat rod groups being disposed on one side of the separator wall, and a second end of each heat rod in each of the heat rod groups being disposed on an opposite side of the separator wall, such that each vessel has the first end of one of the heat rod groups and the seconds end of another one of the heat rod groups; and

wherein the heating box has the first end of the first heat rod group, and the condenser unit has the second end of the ultimate heat rod group;

whereby the preheater of each vessel receives heat the first end of the heat rod group and the sprayer of each vessel deposit feedwater onto the second end of the heat rod group, the second end of the heat rod group condensing freshwater into the condensate tray;

a fresh water tray in communication with each condensate tray of each vessel for receiving fresh water;

a first tubing;

a thermocompressor unit;

a steam source;

wherein the first tubing coupling the steam source to the thermocompressor, and the thermocompressor to the heating box;

a second tubing serially coupling the plurality of sprayers and preheaters of each vessel to a feedwater source;

a first pump for pumping feed water into the condenser unit;

a second pump for pumping feed water from the condenser unit into the second tubing;

a third pump for pumping freshwater from the freshwater tray; and

at least one other pump, the at least one other pump for pumping brine to the feedwater source.

**5**. A method for desalinating seawater, comprising the steps of:

providing a housing successively including a heating box, a plurality of vessels, and a condenser unit: a separator wall disposed between each of adjacent ones of the heating box, the plurality of vessels, and the condenser unit, each one of the plurality of vessels including a demister positioned vertically therein, a thermocompressor unit being connected to the heating box by a first tubing, a plurality of heat rods disposed horizontally between each of the adjacent heating box, plurality of vessels, and condenser unit, each heat rod having a first end on one side of one of the separator walls and a second end on the opposite side of the separator wall, a plurality of preheaters, each of the plurality of preheaters in a respective one of the plurality of vessels, a plurality of sprayers, each of the plurality of sprayers disposed in a respective one of the plurality of vessels, a second tubing extending between a feed water source, the plurality of preheaters, and the plurality of sprayers, and a plurality of pumps for selectively pumping feedwater, brine, and freshwater through the housing;

introducing a first vapor from a steam source into the first tubing and through the thermocompressor unit;

producing a second vapor in at least one of the plurality of vessels;

combining the first vapor and the second vapor to form a third vapor;

directing the third vapor into the heating box;

heating the first ends of the plurality of heat rods in the heating box;

discharging feed water from the feed water source onto the second ends of the plurality of heat rods in a first vessel of the plurality of vessels to create steam;

preheating the feed water prior to discharging the feed water onto the second ends of the plurality of heat rods;

separating water droplets from the steam produced in the first vessel using the demister in the first vessel;

heating the first ends of the plurality of heat rods in the first vessel by the steam;

discharging feed water from the feed water source onto the second ends of the plurality of heat rods in a second vessel of the plurality of vessels to create steam;

preheating the feed water prior to discharging the feed water onto the second ends of the plurality of heat rods;

separating water droplets from the steam produced in the second vessel using the demister in the second vessel;

condensing the steam produced in the second vessel of the plurality of vessels on the condenser unit; and

collecting fresh water.

**6**. The method for desalinating seawater according to claim **5**, wherein feed water is discharged from the feed water source onto the second ends of the plurality of heat rods in the first vessel before feed water is discharged from the feed water source onto the second ends of the plurality of heat rods in the second vessel.

**7**. The method for desalinating seawater according to claim **5**, wherein feed water is simultaneously discharged from the feed water source onto the second ends of the plurality of heat rods in the first vessel and the second vessel.

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